Metadata Report

Project Name

Gad Valley Rock Glacier UAV-based lidar data – September 2024, Salt Lake County, Utah

Summary

As part of an ongoing USGS StateMap funded research project on rock glaciers in Utah, the Utah Geological Survey (UGS) collected point cloud data of a small rock glacier in September 2024. This is the second data acquisition for this project, with the first being in September 2023. The project area is located within Snowbird Ski Resort in Little Cottonwood Canyon, Salt Lake County, Utah. The goal of this project is to perform yearly repeat flights of the area and conduct topographic differencing to detect changes and movement in the body of the rock glacier.

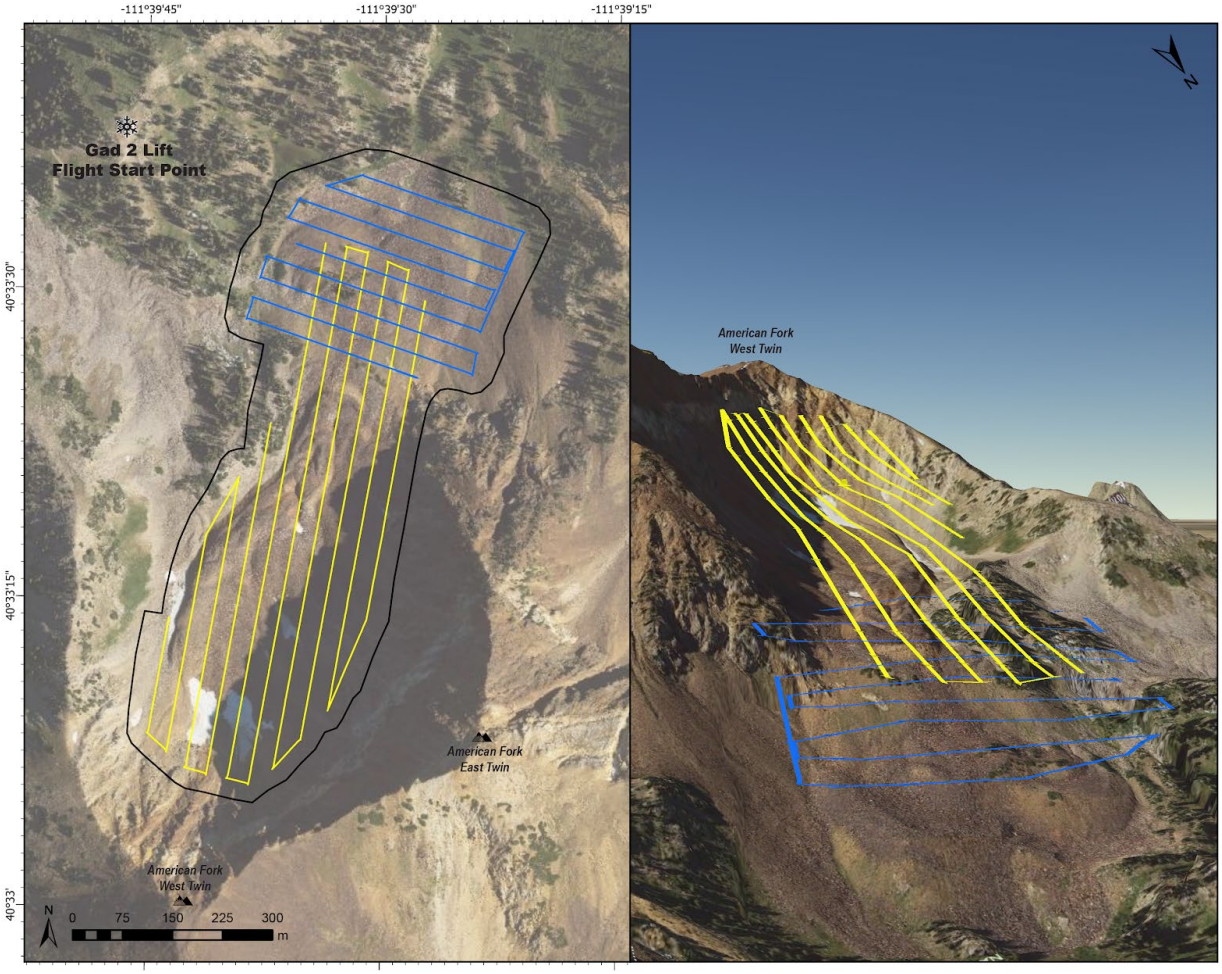
Personnel

- PI(s)
  - Adam I. Hiscock (adamhiscock@utah.gov) & Matthew Morriss (mmmorriss@utah.gov)
- Field staff
  - Adam I. Hiscock, Tara Shreve, Trevor Schlossnagle, and Torri Duncan

Site Information

- Site description
  - Site located in a mountain cirque, near the top of Snowbird Ski Resort, just west of the summit of American Fork Twin Peaks.
- Site objective
  - Collect UAV-based lidar data over a rock glacier to generate point clouds and DEMs for topographic differencing, as part of a multi-year project to monitor movement of rock glaciers in the Central Wasatch Mountains, Utah.

- Site location
    - Snowbird, Utah (40.555749°N 111.659182°W)



- Site conditions

Weather conditions were clear, calm, and cool.

- Date/time spent at each site

9/24/2024 9:51 AM

Survey Results

- Equipment used
    - DJI m300 UAV with a DJI Zenmuse L1 lidar sensor.

- GPS solutions
    - The Utah Reference Network (TURN) GPS was used to provide real-time (RTK) base corrections over a cellular data connection during the flight, for UAV positioning and accuracy.
- Errors
- Alignments
- Collection methods
    - Flights were pre-programmed into the DJI Pilot 2 app on the UAV controller. To collect higher-resolution data, terrain following was used for all flights. An AGL terrain following elevation of 70 m was used for all flights for consistency. The DJI Pilot 2 app requires loading a digital elevation model (DEM) of the study area for terrain following; a 0.5-m resolution DEM generated from 2018 Quality Level 1 (QL1) lidar data (https://gis.utah.gov/products/sgid/elevation/lidar/#2018-central-utah) was used for this purpose.
    - Flights were conducted from the top of the Gad 2 chairlift at Snowbird Ski Resort. This location is accessible via vehicle and provides good sightlines to upper Gad Valley and parts of the target rock glacier, making it suitable for conducting UAV flights. A grid pattern was flown to capture the entire extent of the upper and lower portions of the Gad Valley rock glacier (see map above). An overlap of 60% was used between flight lines, allowing for dense data collection and sufficient point cloud coverage. The Zenmuse L1 lidar scanner specifications used were: scanning mode - repetitive, sampling rate - 240KHz, and return mode - dual. Dual return mode allows for more total points to be collected, but less vegetation penetration, which is suitable for rock glaciers. A UAV speed of 5 m/s was used for all flights.

Products

- Date of dataset collection
    - 9/24/2024
- Coordinate system of datasets
    - Horizontal Datum: UTM Zone 12N, WGS84
    - Vertical Datum: NAVD88
- Spatial Resolution
    - Lidar Point Cloud Resolution (from GlobalMapper)
        - Density: 4622.7 samples/m^2
        - Point Spacing: 0.01471 m
        - Point Count: 720,069,390 points
    - DEM Resolution:

    - 0.5-m resolution DEMs
    - X: 0.5 m
    - Y: 0.5 m
- IMU Trajectory Errors/Accuracy
    - IMU RSME-X: 0.00581 m
    - IMU RSME-Y: 0.00436 m
    - IMU RSME-Z: 0.00554 m
- Data formats
    - Point Cloud – LAZ (.laz)
    - DEM – GeoTiff (.tif)
- Data processing methods
    - LAZ created using DJI Terra 4.2.13
    - DEM generated from LAZ using GlobalMapper Pro v23
    - Initial data processing was conducted in DJI Terra (v4.2.13). Terra loads the proprietary files from the Zenmuse L1 lidar scanner, classifies the point cloud, applies georeferencing, and exports the point cloud in the LAS universal point cloud format (.las). Next, these point clouds were loaded in GlobalMapper Pro (v23.1) for additional quality control and processing. Due to inherent limitations in the design of the Zenmuse L1 lidar scanner, inaccuracies exist in the point cloud along the margins of each individual lidar swath (each swath is collected along each flight line), resulting in misalignment between swaths, which causes artificial lineaments to appear in the final DEM datasets. To correct for these artifacts, the UGS has developed a method to filter out data along the edges of each lidar swath. This method involves filtering out the extreme lidar scan angles created by the side-to-side movement of the lidar scanner hardware (Zenmuse L1). Using GlobalMapper Pro, lidar points collected from scan angles greater than 25 degrees are removed from the point cloud. The max scan angle of the Zenmuse L1 is 30 degrees, so lidar points collected from the most extreme 5 degrees of scan angle (-30° to -25° and +25° to +30°) are removed from the point cloud. This method smooths out the inaccuracies between lidar swaths, and when combined with a high amount of overlap between flight lines (60% for this project), maintains high quality for most datasets.
    - The final exported datasets included here are a DEM at an upscaled resolution of 50 cm/pixel (0.5-m; GeoTiff [.tif] and a ground-point classified point cloud in the compressed LAZ file format (.laz).

Attachments

- DJI Terra processing report

DJI Terra Quality Report

V4.5.0 | 2025-10-20 12:28 | Mission: GVRT_2024_Reprocess

Quality Report for LiDAR Point Cloud Processing

Aircraft Data Collection Time

POS Data Collection Time	**53min 57s**
Point Cloud Data Collection Time	**42min 21s**

Software Processing Time

Point Cloud Optimization Time	**30min 58s**
• Point Cloud Colorization Time	5min 47s
• Output Saving Time	6min 14s
• Others	18min 57s

Reconstruction Parameters

Point Cloud Optimization Parameters

Use custom base station data	**No**
Scenario	**Point Cloud Processing**
Point Cloud Density (By Percentage)	**High(100%)**
Point Cloud Effective Distance Range	**3-300 m**
Accuracy Control and Check	**No**
Optimize Point Cloud Accuracy	**No**
Smooth Point Cloud	**No**

Point Cloud Output Parameters

Point Cloud Format	**PNTS** | **LAS**
Merged Output	**No**
LiDAR Point Cloud Block Count	**3**
2D Map	**No**
Ground Point Classification	**No**
DEM	**No**
Contour	**No**
Output Coordinate System	**WGS 84 / UTM zone 12N** | **NAVD88 height**

Mission Parameters

Aircraft Parameters (Aircraft 1)

Hardware Parameters

Payload	**DJI Zenmuse L1**
Payload SN	**3FCDKC1004JC0H**
LiDAR Parameters	**https://enterprise.dji.com/zenmuse-l1/specs**

LiDAR and IMU Calibration Parameters

Parameters	X	Y	Z	roll	pitch	yaw
Default	**0.03508m**	**0.01694m**	**-0.04644m**	**-0.0225426 rad**	**3.1316636 rad**	**3.1392465 rad**

Flight Parameters (1 Flights)

Average Flight Speed	**4.59m/s**
Flight Height	**218.66m**
Ground Beam Diameter	**1093mm*109mm**
Pulse Rate	**240kHz**
Scan Rate	**720kHz**

Aircraft Parameters (Aircraft 2)

Hardware Parameters

Payload	**DJI Zenmuse L1**
Payload SN	**3FCDKC1004JC0H**
LiDAR Parameters	**https://enterprise.dji.com/zenmuse-l1/specs**

LiDAR and IMU Calibration Parameters

Parameters	X	Y	Z	roll	pitch	yaw
Default	**0.03508m**	**0.01694m**	**-0.04644m**	**-0.0225426 rad**	**3.1316636 rad**	**3.1392465 rad**

Flight Parameters (2 Flights)

Average Flight Speed	**3.93m/s**
Flight Height	**66.88m**
Ground Beam Diameter	**334mm*33mm**
Pulse Rate	**240kHz**
Scan Rate	**720kHz**

Aircraft Parameters (Aircraft 3)

Hardware Parameters

Payload	**DJI Zenmuse L1**
Payload SN	**3FCDKC1004JC0H**
LiDAR Parameters	**https://enterprise.dji.com/zenmuse-l1/specs**

LiDAR and IMU Calibration Parameters

Parameters	X	Y	Z	roll	pitch	yaw
Default	**0.03508m**	**0.01694m**	**-0.04644m**	**-0.0225426 rad**	**3.1316636 rad**	**3.1392465 rad**

Flight Parameters (3 Flights)

Average Flight Speed	**4.04m/s**
Flight Height	**239.24m**
Ground Beam Diameter	**1196mm*119mm**
Pulse Rate	**240kHz**
Scan Rate	**720kHz**

System Parameters

CPU	**Intel Xeon 20 cores**
GPU Count	**2**
GPU 0	**NVIDIA RTX A4000**
GPU 1	**NVIDIA RTX A4000**
RAM	**130304 M**

Accuracy Parameters

POS Status

Fix	**97.48%**
Other	**2.52%**

IMU Trajectory Error

Parameters	X(E) RMSE	Average X(E)	Y(N) RMSE	Average Y(N)	Z(U) RMSE	Average Z(U)
Location	**0.00581 m**	**0.00742 m**	**0.00436 m**	**0.00658 m**	**0.00554 m**	**0.0069 m**
Attitude	**0.0000056 rad**	**0.0001827 rad**	**0.0000045 rad**	**0.0001851 rad**	**0.000074 rad**	**0.0006101 rad**

Output Parameters

Point Cloud Density

Scale	Point Cloud Average Density	Point Cloud Standard Density	Grid Side Length	Total Grid Number	Non-conforming Grid Ratio
1:500	**1763points/m²**	**16points/m²**	**0.25 m**	**2219172**	**1.77%**
1:1000	**1763points/m²**	**4points/m²**	**0.5 m**	**562884**	**1.44%**
1:2000	**1763points/m²**	**1points/m²**	**1 m**	**142744**	**1.42%**

Output List

Point Cloud PNTS LAS